RAYTHEON COMPANY
Microwave and Power Tube Division
Waltham, Massachusetts 02154

AD A074719

LEVEL II

542617

BI-MONTHLY PROGRESS REPORT NO. 5
FOR A
DUAL BEAM DUAL MODE TWT

16 April 1979 through 15 June 1979

Prepared for
Naval Research Laboratory
Washington, D.C.
Under Contract No. N00014-78-C-0791

PT-5459
28 Aug 79

298 320

1.0 INTRODUCTION

The work described in this report is being done for the Office of Naval Research. The program is an outgrowth of work begun in 1974 for the ONR directed towards building a 10 dB pulse-up, liquid cooled, PPM focused high band TWT.

This program is intended to finish development of this tube in time for current and next generation system use and to establish two sources for the device. To achieve this objective, the resources of Raytheon and a subcontractor (Northrop) are being employed in a cooperative development program.

The statement of work for this program is Raytheon proposal No. PRP-4430-1 entitled "Technical Proposal for a Dual Beam Dual Mode TWT", dated 8 June 1978. To insure that all essential system performance factors are adequately addressed, a complete tube specification is being used: specifically, the Dual Mode Steering Committee Dual Mode TWT specification (originally released 12 September 1977) as amended by O.E.M. Submissions to the system statement of work received May 1, 1978.

This program is divided into 4 major phases. The first, critical component verification, has been completed. The second, baseline design evaluation, is addressed to demonstrating via analysis and experimental data, the following items:

1. Collector electrode designs capable of providing 27% CW and 30% pulse overall efficiency over the full frequency range.

2. CW output attenuator and CW helix-bridge-pulse helix matches consistent with stability criteria established during Phase I.

3. The ability of the waveguide-coax transitions in a back-to-back configuration to handle 500 W CW and 5 Kw peak.

4. The ability of the package with a TWT thermal mock up to dissipate P + 10.4 dBm (CW only), P + 9.1 dBm (pulse only) and P + 11.8 dBm (CW and pulse simultaneously) with max. magnet and collector temperature of less than 200°C in a simulated system environment.

5. The ability of the electron beam formation and focusing system to provide 97% CW and 90% pulse mode beam transmission.

6. The ability of the CW-pulse interconnect bridge to withstand four 500°C bakeout cycles with no evidence of damage.

7. A definition of life cycle cost, reliability considerations, and operational differences.

8. Performance of at least one baseline design TWT by each company. (An ETP will be written and approved before testing)

2.0 PRIME PARTS

All long lead time prime parts were ordered during this period.

3.0 COLLECTOR ELECTRICAL DESIGN

Computer design of the CW stage collector is nearly completed. The spent beam characteristics have been determined using a large signal computer program and these beam figures were used as input to the collector program. Evaluation of the original electrode configuration is in process and it appears that the original design will be usable as is or with minor modifications.

4.0 CW STAGE MAIN ATTENUATOR

The electrical design of the rf circuit was done on the computer using the Raytheon large-scale interaction program during Phase I. For this design

an idealized attenuator envelope configuration consisting of five straight lines was used. The actual attenuator configuration required to minimize reflections is a smooth curve, particularly on the tails.

During this period, a smooth-shaped attenuator pattern was developed by modifying the original idealized curve and running the computer program to insure that the expected tube performance was not changed by the attenuator shape change.

5.0 BRIDGE-HELIX MATCHING

QKW1783 tubes S/N 16 and S/N 17 were tested on the automatic network analyzer to determine the mismatch in the helix-bridge-helix area. Both tubes showed a 1.3 VSWR maximum over this region, but further work will be necessary to determine the exact plane of the ends of the bridge. New bridge test vehicles were designed to allow testing of the new, longer bridge configuration and parts were ordered.

6.0 WAVEGUIDE-COAX TRANSITION

Detailed parts design for this unit was completed during this period and waveguide castings were ordered.

7.0 THERMAL MOCK-UP OF PACKAGE

Work on this item has not been started due to delays in schedule at Northrop DSD.

8.0 ELECTRON BEAM FORMATION

Focusing systems were designed for both stages to provide the increased magnetic field required to focus the new higher power version. Parts were designed and ordered for test barrels to be used to develop the new magnets.

Beam testers for both stages were designed and parts were ordered. Guns and collectors for these units will be taken from S/N 17.

9.0 PULSE STAGE ELECTRICAL DESIGN

The rf design of the pulse stage done during Phase I was based on a heat-shrunk boralloy supported helix. At the end of Phase I, the decision was made to use the brazed beryllia support design for the pulse stage. This requires that the beryllia circuit properties be investigated and that corresponding adjustments be made in the circuit velocity to match the original computer design. Towards the end, a beryllia-supported helix structure was cold tested and the results will be used to determine the adjustments necessary.

10.0 MECHANICAL AND ELECTRICAL DESIGN

The CW barrel was designed; this barrel will be split into two sections at the center of the main attenuator to facilitate heat-shrinking of the helices.

The coax output of the pulse stage was redesigned to include a boron nitride supported center conductor ahead of the window. This change was necessary because the window was placed farther away from the helix than in the original design. This window relocation was necessary to allow welding access for the window, that access being limited by the proximity of the new, larger collector. The drift section between the output and the collector was reduced in length by eliminating the magnet beyond the output cell magnet to improve collector performance.

The detailed design of the new, elongated bridge and its connection to the barrels was completed.

11.0 PROGRAM SCHEDULE

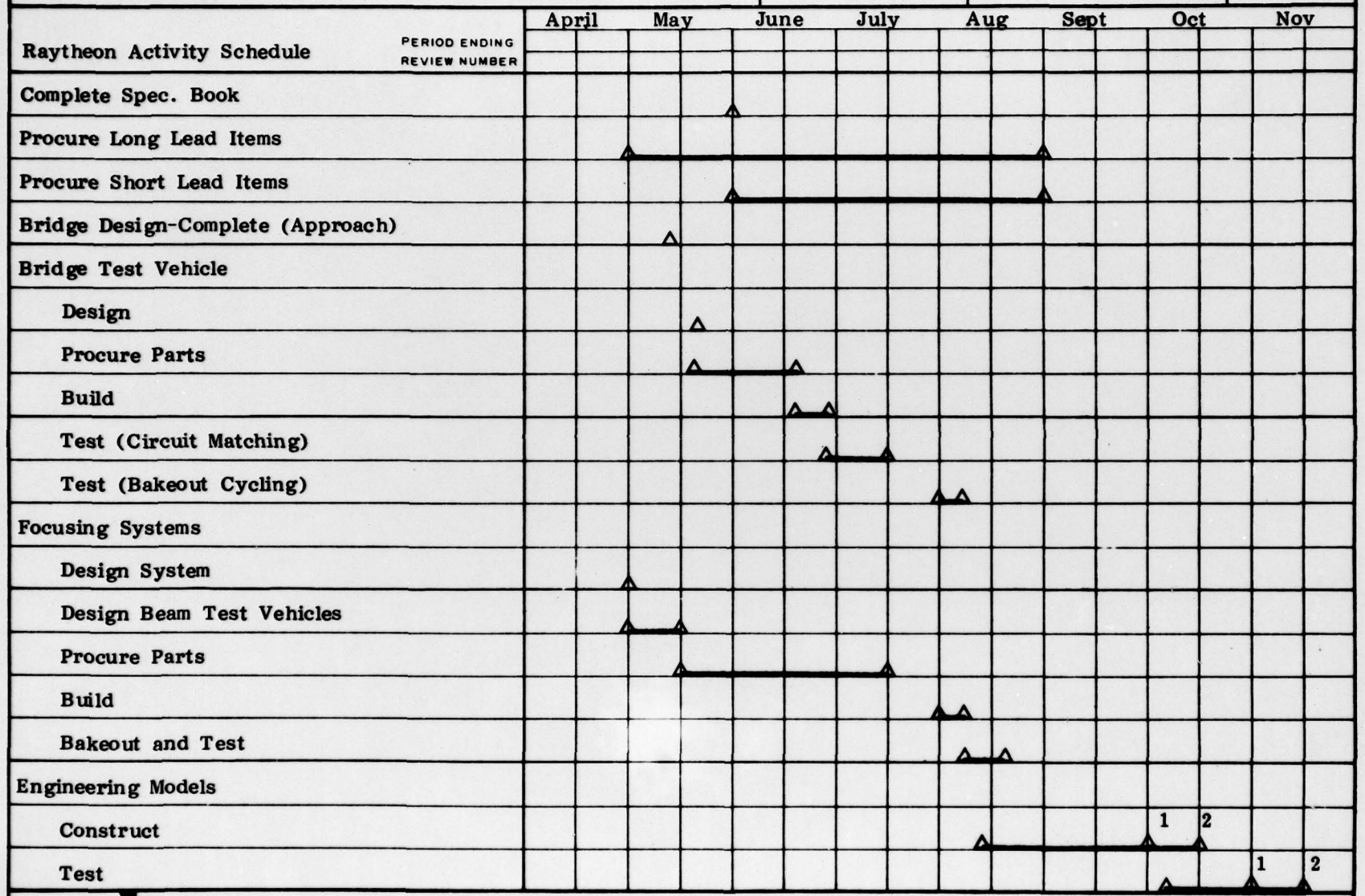
Program schedules for Phase II activity at Raytheon and Northrop are attached.

RAYTHEON 10-0231 (6/70)

PROJECT SCHEDULE

☐ IDP ☐ IRP

PROJECT TITLE	PROPOSAL NO.	PROJECT LEADER	DIVISION
DUAL MODE PHASE II			



SYMBOLOGY FOR CHART

- = LOWER LINE INDICATES: PLANNED PERIOD OF PERFORMANCE
- = UPPER LINE INDICATES: FORECAST DIFFERENT FROM PLAN
- = ACTUAL START, FORECAST COMPLETION
- = ACTUAL START & ACTUAL COMPLETION
- = PLANNED EXPENDITURES
- = ACTUAL EXPENDITURES

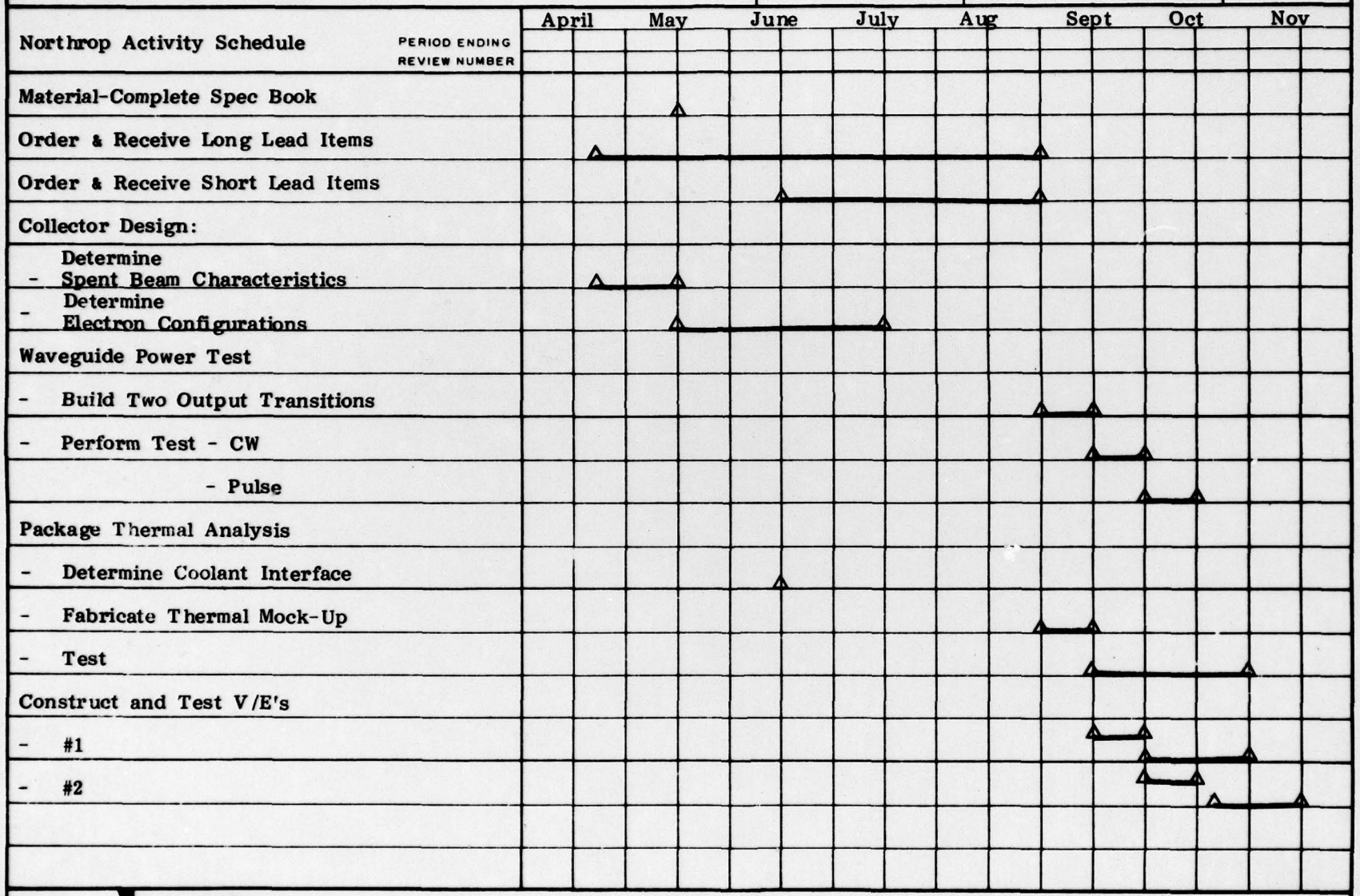
NOTE: NUMBER THE SYMBOLS ON THE UPPER BAR TO CORRESPOND WITH THE REVIEW NUMBER.

RAYTHEON 10-0231 (6/70)

PROJECT SCHEDULE

☐ IDP ☐ IRP

PROJECT TITLE	PROPOSAL NO.	PROJECT LEADER	DIVISION
DUAL MODE PHASE II			



SYMBOLOGY FOR CHART

- ▲——▲ = LOWER LINE INDICATES: PLANNED PERIOD OF PERFORMANCE
- ○——● = UPPER LINE INDICATES: FORECAST DIFFERENT FROM PLAN
- ●——● = ACTUAL START, FORECAST COMPLETION
- ●——▲ = ACTUAL START & ACTUAL COMPLETION
- - - - - = PLANNED EXPENDITURES
- ——— = ACTUAL EXPENDITURES

NOTE: NUMBER THE SYMBOLS ON THE UPPER BAR TO CORRESPOND WITH THE REVIEW NUMBER.